Exercise-1

✍ **Marked Questions may have for Revision Questions.**

OBJECTIVE QUESTIONS

Section (A) : Calculation related to nucleus

A-1.✍ Atomic radius is of the order of 10^{-8} cm and nuclear radius is of the order of 10^{-13} cm. Calculate what fraction of atom is occupied by nucleus?
(1) 10^{-20} (2) 10^{-15} (3) 10^{-12} (4) None

A-2.✍ Atomic weight of an element is not necessarily whole number because
(1) it contains electrons, protons and neutrons (2) it contains allotropic forms
(3) atoms are no longer considered indivisible (4) it contains isotopes

A-3. The charge on the atom having 17 protons, 18 neutrons and 18 electrons is
(1) + 1 (2) – 1 (3) – 2 (4) zero

A-4. Which of the following are isoelectronic with one another ?
(1) Na^+ and Ne (2) K^+ and O (3) Ne and O (4) Na^+ and K^+

A-5. Millikan's oil drop expriments is used to find -
(1) e/m ratio of an electron (2) Charge on an electron
(3) Mass of an electron (4) Velocity of an electron

A-6. Which of the following is isoelectronic with N_2O :
(1) NO (2) N_2O_5 (3) CO_2 (4) CO

A-7. The e/m is not constant for :
(1) Cathode rays (2) Positive rays (3) α-rays (4) β-rays

A-8.✍ Which one of the following pairs represents isobars -
(1) $_2He^3$ and $_2He^4$ (2) $_{12}Mg^{24}$ and $_{12}Mg^{25}$
(3) $_{19}K^{40}$ and $_{19}K^{39}$ (4) $_{19}K^{40}$ and $_{18}Ar^{40}$

A-9. Cathode rays are made up of
(1) Positively charged particles (2) Negatively charged particles
(3) Neutral particles (4) None of these

A-10. Cathode rays have
(1) Mass only (2) Charge only
(3) No mass and charge (4) Mass and charge both

A-11. Which one of the following pairs is not correctly matched
(1) Rutherford-Proton (2) J.J. Thomsom-Electron
(3) J.H. Chadwick-Neutron (4) Bohr-Isotope

A-12. The nature of anode rays depends upon
(1) Nature of electrode (2) Nature of gas
(3) Nature of discharge tube (4) All the above

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A-13. The ratio of the "e/m" (specific charge) values of a electron and an α-particle is -
(1) 2 : 1 (2) 1 : 1 (3) 1 : 2 (4) None of these

A-14. The positive charge of an atom is
(1) Spread all over the atom (2) Distributed around the nucleus
(3) Concentrated at the nucleus (4) All of these

A-15. The mass of an atom is constituted mainly by
(1) Neutron and neutrino (2) Neutron and electron
(3) Neutron and proton (4) Proton and electron

A-16. Neutrons are found in atoms of all elements except in
(1) Chlorine (2) Oxygen (3) Argon (4) Hydrogen

A-17. Six protons are found in the nucleus of
(1) Boron (2) Lithium (3) Carbon (4) Helium

A-18.✍ When atoms are bombarded with alpha particles, only a few in million suffer deflection, others pass out undeflected. This is because
(1) The force of repulsion on the moving alpha particle is small
(2) The force of attraction on the alpha particle to the oppositely charged electrons is very small
(3) There is only one nucleus and large number of electrons
(4) The nucleus occupies much smaller volume compared to the volume of the atom

Section (B) : Quantum theory of light and photoelectric Effect

B-1.✍ AIR service on Vividh Bharati is transmitted on 219 m band. What is its transmission frequency in Hertz?
(1) 1.3×10^6 Hz (2) 1.9×10^6 Hz (3) 1×10^6 Hz (4) 6.5×10^6 Hz

B-2.✍ If 10^{-17}J of light energy is needed by the interior of human eye to see an object. The number of photons of green light (λ = 550 nm) needed to see the object are :
(1) 27 (2) 28 (3) 29 (4) 30

B-3. Which of the following statements is false :
(1) The energy of red photon is more than the energy of violet photon
(2) The momentum of photon is inversely proportional to its wave length
(3) The energy of a photon is inversely proportional to its wave length
(4) The particle nature of electromagnetic radiations is able to explain the photoelectric effect

B-4.✍ Light of wavelength λ falls on metal having work function hc/λ_0. Photoelectric effect will take place only if :
(1) $\lambda \geq \lambda_0$ (2) $\lambda \geq 2\lambda_0$ (3) $\lambda \leq \lambda_0$ (4) $\lambda \leq \lambda_0/2$

B-5. A photon in X region is more energetic than in the visible region ; X is :
(1) IR (2) UV (3) Microwave (4) Radio wave

B-6.✍ A bulb of 40 W is producing a light of wavelength 620 nm with 80% of efficiency then the number of photons emitted by the bulb in 20 seconds are (1eV = 1.6×10^{-19} J, hc = 12400 eV Å)
(1) 2×10^{18} (2) 10^{18} (3) 10^{21} (4) 2×10^{21}

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B-7. Which one of the following is not the characteristic of Planck's quantum theory of radiation-
(1) The energy is not absorbed or emitted in whole number multiple of quantum.
(2) Radiation is associated with energy.
(3) Radiation energy is not emitted or absorbed continously but in the form of small packets called quanta.
(4) This magnitude of energy associated with a quantum is proportional to the frequency.

B-8. Calculate the frequency of a photon of wavelength 4000 Å
(1) 7.5×10^{14} s^{-1} (2) 7.5×10^{-16} s^{-1} (3) 8×10^{-14} s^{-1} (4) 6.5×10^{-15} s^{-1}

B-9. Calculate the wavelength of a photon having an energy of 2 electron volt
(1) 6.204×10^{-7} m (2) 6.206×10^{-6} m (3) 6.204×10^{-9} m (4) 6.204×10^{-8} m

B-10. Photoelectric effect is maximum in :
(1) Cs (2) Na (3) K (4) Li

B-11. The MRI (magentic resonance imaging) body scanners used in hospitals operate with 400 MHz radio frequency. The wavelength corresponding to this radio frequency is
(1) 0.75 m (2) 0.75 cm (3) 1.5 m (4) 2 cm

B-12. Photon of which light has maximum energy :
(1) red (2) blue (3) violet (4) green

Section (C) : Bohr Model

C-1. The ionization energy of He^+ is 19.6×10^{-18} J $atom^{-1}$. The energy of the first stationary state of Li^{+2} will be:
(1) 84.2×10^{-18} J/atom (2) 44.10×10^{-18} J/atom
(3) 63.2×10^{-18} J/atom (4) 21.2×10^{-18} J/atom

C-2. Energy required to pull out an electron from 1^{st} orbit of hydrogen atom to infinity is 100 units. The amount of energy needed to pull out the electron from 2nd orbit to infinity is :
(1) 50 units (2) 100 units (3) 25 units (4) Zero

C-3. The ionization energy of H-atom is 13.6 eV. The ionization energy of Li^{+2} ion will be :
(1) 54.4 eV (2) 122.4 eV (3) 13.6 eV (4) 27.2 eV

C-4. Which of the following electron transition in a hydrogen atom will require the largest amount of energy ?
(1) From n = 1 to n = 2 (2) From n = 2 to n = 3 (3) From n = ∞ to n = 1 (4) From n = 3 to n = 5

C-5. What is likely to be orbit number for a circular orbit of diameter 20 nm of the hydrogen atom if we assume Bohr orbit to be the same as that represented by the principal quantum number?
(1) 10 (2) 14 (3) 12 (4) 16

C-6. If velocity of an electron in I orbit of H atom is V, what will be the velocity of electron in 3^{rd} orbit of Li^{+2}
(1) V (2) V/3 (3) 3 V (4) 9 V

C-7. Match the following
(A) Energy of ground state of He^+ (i) + 6.04 eV
(B) Potential energy of I orbit of H-atom (ii) –27.2 eV
(C) Kinetic energy of II excited state of He^+ (iii) 54.4 V

(D) Ionisation potential of He^+ (iv) – 54.4 eV
(1) A – (i), B – (ii), C – (iii), D – (iv) (2) A – (iv), B – (iii), C – (ii), D – (i)
(3) A – (iv), B – (ii), C – (i), D – (iii) (4) A – (ii), B – (iii), C – (i), D – (iv)

C-8. **S_1 :** Bohr model is applicable for Be^{2+} ion.
S_2 : Total energy coming out of any light source is integral multiple of energy of one photon.
S_3 : Number of waves present in unit length is wave number.
S_4 : e/m ratio in cathode ray experiment is independent of the nature of the gas.
(1) F F T T (2) T T F F (3) F T T T (4) T F F F

C-9. **S_1 :** Potential energy of the two opposite charge system increases with the decrease in distance.
S_2 : When an electron make transition from higher orbit to lower orbit it's kinetic energy increases.
S_3 : When an electron make transtition from lower energy to higher energy state its potential energy increases.
S_4 : 11eV photon can free an electron from the 1st excited state of He^+ -ion.
(1) T T T T (2) F T T F (3) T F F T (4) F F F F

C-10. If r_1 is the radius of the first orbit of hydrogen atom, then the radii of second, third and fourth orbits in terms of r_1 are :
(1) r_1^2, r_1^3, r_1^4 (2) $8r_1$, $27r_1$, $64r_1$ (3) $4r_1$, $9r_1$ $16r_1$ (4) $2r_1$, $6r_1$, $8r_1$

C-11. Bohr's model can explain :
(1) The spectrum of hydrogen atom only
(2) The spectrum of atom or ion containing one electron only
(3) The spectrum of hydrogen molecule only
(4) The solar spectrum

C-12. If electron falls from n= 3 to n = 2, then emitted energy is :
(1) 10.2 eV (2) 12.09 eV (3) 1.9 eV (4) 0.65 eV

C-13. The maximum energy is present in any electron at
(1) Nucleus (2) Ground state
(3) First excited state (4) Infinite distance from the nucleus

Section (D) : Spectrum

D-1. If the series limit of wavelength of the Lyman series for the hydrogen atoms is 912Å, then the series limit of wavelength for the Balmer series of the hydrogen atom is :
(1) 912 Å (2) 912 × 2 Å (3) 912 × 4 Å (4) 912/2 Å

D-2. The shortest wave length in H spectrum of Lymen series when $R_H = 109678\ cm^{-1}$ is
(1) 1002.7 Å (2) 1215.67 Å (3) 1127.30 Å (4) 911.7 Å

D-3. According to Bohr's theory, the angular momentum for an electron in 5th orbit is :
(1) 2.5 h/π (2) 5 h/π (3) 25 h/π (4) 5π /2h

D-4. Transition of an electron from n = 3 to n = 1 level results in
(1) emission spectrum (2) band spectrum (3) infrared spectrum (4) X-ray spectrum

D-5. If r is the radius of first orbit, the radius of nth orbit of H atom is given by -

(1) r n (2) r n^2 (3) r/n (4) r^2 n^2

D-6. The radius of hydrogen in ground state is 0.53 Å. In normal state the radius of Li^{2+} (atomic number = 3) in ground state will be :
(1) 1.06 Å (2) 0.265 Å (3) 0.17 Å (4) 0.53 Å

D-7. The minimum energy required to excite a hydrogen atom from its ground state is -
(1) 3.4 eV (2) 13.6 eV (3) – 13.6 eV (4) 10.2 eV

D-8.✍ The separation energy of the electron present in the shell n = 3 is 1.51 eV. What is the energy in the first excited state –
(1) –1.51 eV (2) –3.4 eV (3) +1.51 eV (4) +3.4 eV

D-9. The wavelength of a spectral line for an electronic transition is inversely related to :

(1) number of electrons undergoing transition
(2) the nuclear charge of the atom
(3) the velocity of an electron undergoing transition
(4) the difference in the energy levels involved in the transition

D-10.✍ In a sample of H-atom electrons make transition from 5^{th} excited state to ground state, producing all possible types of photons, then number of lines in infrared region are
(1) 4 (2) 5 (3) 6 (4) 3

D-11.✍ Calculate wavelength of 3^{rd} line of Bracket series in hydrogen spectrum
(1) $\frac{784}{33R}$ (2) $\frac{33R}{784}$ (3) $\frac{784R}{33}$ (4) $\frac{33}{784R}$

D-12. In Balmer series of hydrogen atom spectrum which electronic transition causes third line
(1) Fifth Bohr orbit to second one (2) Fifth Bohr orbit to first one
(3) Fourth Bohr orbit to second one (4) Fourth Bohr orbit to first one

D-13 . The emission spectrum of hydrogen is found to satisfy the expression for the energy change. ΔE (in joules) such that $\Delta E = 2.18 \times 10\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) J$ where n_1 = 1, 2, 3….. and n_2 = 2, 3, 4……. The spectral lines correspond to Paschen series to
(1) n_1 = 1 and n_2 = 2, 3, 4 (2) n_1 = 3 and n_2 = 4, 5, 6
(3) n_1 = 1 and n_2 = 3, 4, 5 (4) n_1 = 2 and n_2 = 3, 3, 5

D-14.✍ Calculate the wavelength of 1^{st} line of Balmer series in Hydrogen spectrum.
(1) 6656 Å (2) 6266 Å (3) 6626 Å (4) 6566 Å

D-15. Different lines in Lyman series of hydrogen spectrum lie in
(1) ultraviolet (2) infrared (3) visible (4) none of these

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D-16. The transition of the electron in hydrogen atom from the fourth to first energy shell emits a spectral line which falls in following series.

(1) Lyman (2) Balmer (3) Pashen (4) Bracket

D-17. When an electron in an excited hydrogen atom jumps from an energy level for which n = 5 to a lower level for which n = 2 , the spectral line is observed in the ....region and in ....series of the hydrogen spectrum.

(1) Visible, Balmer (2) Visible, lyman (3) Infrared, lyman (4) Infrared, Balmer

D-18. Which of the following transition is correct for Balmer series ?

(1) $3 \rightarrow 1$ (2) $1 \rightarrow 2$ (3) $4 \rightarrow 2$ (4) $2 \rightarrow 4$

Section (E) : De broglie wavelength & Uncertainity principle

E-1. What possibly can be the ratio of the de Broglie wavelengths for two electrons each having zero initial energy and accelerated through 50 volts and 200 volts ?

(1) 3 : 10 (2) 10 : 3 (3) 1 : 2 (4) 2 : 1

E-2. The speed of a proton is one hundredth of the speed of light in vacuum. What is its de-Broglie wavelength? Assume that one mole of protons has a mass equal to one gram.

[h = 6.626×10^{-27} erg sec] :

(1) 13.31×10^{-7} Å (2) 1.33×10^{-3} Å (3) 13.13×10^{-5} Å (4) 1.31×10^{-2} Å

E-3. An α-particle is accelerated through a potential difference of V volts from rest. The de-Broglie's wavelength associated with it is

(1) $\sqrt{\frac{150}{V}}$ Å (2) $\frac{0.286}{\sqrt{V}}$ Å (3) $\frac{0.101}{\sqrt{V}}$ Å (4) $\frac{0.983}{\sqrt{V}}$ Å

E-4. The uncertainity in position and velocity of a particle are 10^{-10} m and 5.27×10^{-24} ms^{-1} respectively. Calculate the mass of the particle (h = 6.625×10^{-34} Joule sec.)

(1) 0.099 Kg (2) 0.089 Kg (3) 0.99 Kg (4) Can not predict

E-5. It the uncertainity in position of a moving particle is 0 then find out ΔP

(1) 0 (2) 1 (3) ∞ (4) Can not predict

E-6. The de Broglie equation suggests that an electron has

(1) Particle nature (2) Wave nature
(3) Particle-wave nature (4) Radiation behaviour

E-7. The Uncertainity in the momentum of an electron is 1.0×10^{-5} kg m s^{-1} . The Uncertainity in its position will be: (h = 6.626×10^{-34} Js)

(1) 1.05×10^{-28} m (2) 1.05×10^{-26} m (3) 5.27×10^{-30} m (4) 5.25×10^{-28} m

E-8. Which of the following has least de Broglie λ

(1) e^- (2) p (3) CO_2 (4) SO_2

E-9. A helium molecule is moving with a velocity of 2.40×10^2 ms^{-1} at 300k. The de-Broglie wave length is about

(1) 0.416 nm (2) 0.83 nm (3) 803 Å (4) 8000 Å

Exercise-1

E-10. In H-atom, if 'x' is the radius of the first Bohr orbit, de Broglie wavelength of an electron in 3rd orbit is :

(1) 3 π x (2) 6 π x (3) $\frac{9x}{2}$ (4) $\frac{x}{2}$

E-11. The wavelength of a charged particle ________the square root of the potential difference through which it is accelerated :

(1) is inversely proportional to (2) is directly proportional to
(3) is independent of (4) is unrelated with

E-12. A ball weight 25 g moves with a velocity of 6.6×10^4 cm/sec then find out the de Broglie wavelength.

(1) 0.4×10^{-33} cm (2) 0.4×10^{-31} cm (3) 0.4×10^{-30} cm (4) 0.4×10^{20} cm

E-13. Calculate the uncertainity in velocity of a cricket ball of mass 150 g if the uncertainity in its position is of the order of 1 Å ($h = 6.6 \times 10^{-34}$ Kg m^2 s^{-1})

(1) 3.499×10^{-24} ms^{-1} (2) 3.499×10^{-21} ms^{-1} (3) 3.499×10^{-20} ms^{-1} (4) 3.499×10^{-30} ms^{-1}

E-14. The de-Broglie equation applies

(1) To electrons only (2) To neutrons only
(3) To protons only (4) All the material object in motion

E-15. The uncertainty in momentum of an electron is 1×10^{-5} kg-m/s. The uncertainty in its position will be : ($h = 6.62 \times 10^{-34}$ kg-m^2/s)

(1) 1.05×10^{-28} m (2) 1.05×10^{-26} m (3) 5.27×10^{-30} m (4) 5.27×10^{-28} m

Section (F) : Quantum numbers & Electronic configuration

F-1. The orbital angular momentum of an electron in 2s-orbital is -

(1) $\frac{h}{4\pi}$ (2) zero (3) $\frac{h}{2\pi}$ (4) $\sqrt{2}\,\frac{h}{2\pi}$

F-2. Which of the following set of quantum numbers are permitted

(1) n = 3, l = 2, m = – 2, s = +1/2 (2) n = 3, l = 2, m = – 1, s = 0
(3) n = 2, l = 2, m = +1, s = – 1/2 (4) n = 2, l = 2, m = +1, s = – 1/2

F-3. A given orbital is labeled by the magnetic quantum number m = –1. This could not be

(1) s - orbital (2) p-orbital (3) d-orbital (4) f-orbital

F-4. Magnetic quantum number specifies -

(1) Size of orbitals (2) Shape of orbitals
(3) Orientation of orbitals (4) Nuclear stability

F-5. For the energy levels in an atom which one of the following statements is correct :

(1) The 4s sub-energy level is at a higher energy than the 3d sub-energy level
(2) The second principal energy level can have five orbitals and contain a maximum of 10 electrons
(3) The M-energy level can have maximum of 32 electrons
(4) None of these

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F-6. Which of the following represents the correct set of quantum numbers of a 4d electron ?

(1) 4, 3, 2, $+\frac{1}{2}$ (2) 4, 2, 1, 0 (3) 4, 3, – 2, $+\frac{1}{2}$ (4) 4, 2, 1, $-\frac{1}{2}$

F-7. A p-orbital can accommodate

(1) 4 electrons (2) 6 electrons
(3) 2 electrons with parallel spins (4) 2 electrons with opposite spins

F-8. An orbital containing electron having quantum number n = 4, *l* = 3, m = 0 and s = $-\frac{1}{2}$ is called

(1) 3s orbital (2) 3p orbital (3) 4d orbital (4) 4f orbital

F-9. The maximum number of electrons in a subshell is given by the expression

(1) $4\ell - 2$ (2) $4\ell + 2$ (3) $2\ell + 2$ (4) $2n^2$

F-10. The electrons present in K-shell of the atom will differ in

(1) principal quantum number (2) azimuthal quantum number
(3) magnetic quantum number (4) spin quantum number

F-11. Magnetic moment of X^{n+} (Z = 26) is $\sqrt{24}$ B.M. Hence number of unpaired electrons and value of n respectively are :

(1) 4, 2 (2) 2, 4 (3) 3, 1 (4) 0, 2

F-12. For an electron, with n = 3 has only one radial node. The orbital angular momentum of the electron will be

(1) 0 (2) $\sqrt{6}\,\frac{h}{2\pi}$ (3) $\sqrt{2}\,\frac{h}{2\pi}$ (4) $3\left(\frac{h}{2\pi}\right)$

F-13. The maximum number of 3d-electrons having spin quantum number s = +1/2 are -

(1) 10 (2) 14 (3) 5 (4) None of these

F-14. In which $(n + \ell)$ rules not applicable -

(1) Cu, Cr (2) Cu, Zn (3) Ag, Zn (4) All of these

F-15. The quantum numbers for the outermost electron of an element are given below as n = 2, l = 0, m = 0, s = $+\frac{1}{2}$. The atoms is :

(1) Lithium (2) Beryllium (3) Hydrogen (4) Boron

F-16. An element has the electronic configuration $1s^2$, $2s^2\,2p^6$, $3s^2\,3p^2$. Its valency electrons are :

(1) 6 (2) 2 (3) 3 (4) 4

F-17. The number of orbitals in 2p sub-shell is :

(1) 6 (2) 2 (3) 3 (4) 4

F-18. Which of the following has the least energy :

(1) 2p (2) 3p (3) 2s (4) 4d

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F-19. Which of the following principles/rules limits the maximum number of electrons in an orbital to two **[CBSE PMT 1989]**

(1) Aufbau principle (2) Pauli's exclusion principle
(3) Hund's rule of maximum multiplicity (4) Heisenberg's uncertainty principle

Exercise-2

✍ **Marked Questions may have for Revision Questions.**

PART - I : OBJECTIVE QUESTIONS

1. For $\ell = 1$, n = 3 the corresponding orbitals are -

(1) s, p_x, p_y (2) s, p_z, p_y (3) s, p_x, d_{xy} (4) p_x, p_y, p_z

2. A sodium cation has different number of electrons from :
(1) O^{2-} (2) F^- (3) Li^+ (4) Al^{3+}

3. Number of electrons in $-CONH_2$ is :
(1) 22 (2) 24 (3) 20 (4) 28

4. If the atomic weight of an element is 23 times that of the lightest element and it has 11 protons, then it contains :
(1) 11 protons, 23 neutrons, 11 electrons (2) 11 protons, 11 neutrons, 11 electrons
(3) 11 protons, 12 neutrons, 11 electrons (4) 11 protons, 11 neutrons, 23 electrons

5.✍ A photon of 300 nm is absorbed by a gas and then emits two photons. One photon has a wavelength 496 nm then the wavelength of second photon in nm :
(1) 759 (2) 859 (3) 959 (4) 659

6.✍ If the energy of an electron in hydrogen atom is given by expression, $-1312/n^2$ kJ mol^{-1}, then the energy required to excite the electron from ground state to second orbit is
(1) 328 kJ/mol (2) 656 kJ/mol (3) 984 kJ/mol (4) 1312 kJ/mol

7. The ionization energy of H atom is 13.6 eV what will be ionization energy of He^+ and Li^{+2} ions-
(1) - 54.4 ev and - 12.2 ev (2) 122.4 ev and 55.4 ev
(3) 54.4 ev and 122.4 ev (4) 12.1 ev and 13.6 ev

8.✍ The frequency corresponding to transition n = 2 to n = 1 in hydrogen atom is :
(1) 15.66×10^{10} Hz (2) 24.66×10^{14} Hz (3) 30.57×10^{14} Hz (4) 40.57×10^{24} Hz

9.✍ The difference between the wave number of 1st line of Balmer series and last line of paschen series for Li^{2+} ion is :
(1) $\frac{R}{36}$ (2) $\frac{5R}{36}$ (3) 4R (4) $\frac{R}{4}$

10.✍ The wave number of electromagnetic radiation emitted during the transition of electron in between two levels of Li^{2+} ion whose principal quantum numbers sum is 4 and difference is 2 is :

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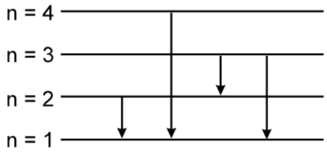
(1) 3.5 R_H (2) 4 R_H (3) 8 R_H (4) $\frac{8}{9} R_H$

11. No. of visible lines when an electron returns from 5th orbit to ground state in H spectrum -
(1) 5 (2) 4 (3) 3 (4) 10

12. If the shortest wave length of Lyman series of H atom is x, then the wave length of the first line of Balmer series of H atom will be -
(1) 9x/5 (2) 36x/5 (3) 5x/9 (4) 5x/36

13. Suppose that a hypothetical atom gives a red, green, blue and violet line spectrum. Which jump according to figure would give off the red spectral line.



(1) $3 \rightarrow 1$ (2) $2 \rightarrow 1$ (3) $4 \rightarrow 1$ (4) $3 \rightarrow 2$

14. If wavelength is equal to the distance travelled by the electron in one second, then -
(1) $\lambda = \frac{h}{p}$ (2) $\lambda = \frac{h}{m}$ (3) $\lambda = \sqrt{\frac{h}{p}}$ (4) $\lambda = \sqrt{\frac{h}{m}}$

15. de-Broglie wavelength of electron in second orbit of Li^{2+} ion will be equal to de-Broglie of wavelength of electron in
(1) n = 3 of H-atom (2) n = 4 of C^{5+} ion (3) n = 6 of Be^{3+} ion (4) n = 3 of He^+ ion

16. De Broglie wavelength of an electron after being accelerated by a potential difference of V volt from rest is
(1) $\lambda = \frac{12.3}{\sqrt{h}}$ Å (2) $\lambda = \frac{12.3}{\sqrt{V}}$ Å (3) $\lambda = \frac{12.3}{\sqrt{E}}$ Å (4) $\lambda = \frac{12.3}{\sqrt{m}}$ Å

17. What is the de-Broglie wavelength associated with the hydrogen electron in its third orbit :
(1) 9.96×10^{-10} cm (2) 9.96×10^{-8} cm (3) 9.96×10^{4} cm (4) 9.96×10^{8} cm

18. Uncertainity in position is twice the Uncertainity in momentum. Uncertainity in velocity is :
(1) $\sqrt{\frac{h}{\pi}}$ (2) $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$ (3) $\frac{1}{2m}\sqrt{\square}$ (4) $\frac{h}{4\pi}$

19. Which orbital is non-directional :
(1) s (2) p (3) d (4) All

20. If n and ℓ are respectively the principal and azimuthal quantum numbers, then the expression for calculating the total number of electrons in any orbit is -
(1) $\sum_{\ell=1}^{\ell=n} 2(2\ell+1)$ (2) $\sum_{\ell=1}^{\ell=n-1} 2(2\ell+1)$ (3) $\sum_{\ell=0}^{\ell=n+1} 2(2\ell+1)$ (4) $\sum_{\ell=0}^{\ell=n-1} 2(2\ell+1)$

Exercise-1

21. After np orbitals are filled, the next orbital filled will be :

(1) (n + 1) s (2) (n + 2) p (3) (n + 1) d (4) (n + 2) s

22. Which of the above statement (s) is/are **false.**

I. Orbital angular momentum of the electron having n = 5 and having value of the azimuthal quantum number as lowest for this principle quantum number is $\frac{h}{\pi}$.

II. If n = 3, ℓ = 0, m = 0, for the last valence shell electron, then the possible atomic number may be 12 or 13.

III. Total spin of electrons for the atom $_{25}Mn$ is $\pm\frac{7}{2}$.

IV. Spin magnetic moment of inert gas is 0

(1) I, II and III (2) II and III only (3) I and IV only (4) None of these

23. In case of $d_{x^2-y^2}$ orbital

(1) Probability of finding the electron along x-axis is zero.

(2) Probability of finding the electron along y-axis is zero.

(3) Probability of finding the electron is maximum along x and y-axis.

(4) Probability of finding the electron is zero in x-y plane

24. Match List-I with List-II and select the correct answer using the codes given below the lists (ℓ and m are respectively the azimuthal and magnetic quantum no.)

List-I	List-II
(A) Number of value of ℓ for an energy level	(1) 0, 1, 2, ... (n - 1)
(B) Value of ℓ for a particular type of orbital	(2) $+\ell$ to $-\ell$ through zero
(C) Number of values of m for ℓ = 2	(3) 5
(D) Value of 'm' for a particular type of orbital	(4) n

Code :

	A	B	C	D		A	B	C	D
(1)	4	1	2	3	(2)	4	1	3	2
(3)	1	4	2	3	(4)	1	4	3	2

25. Nitrogen has the electronic configuration $1s^2,2s^22p_x^12p_y^12p_z^1$ and not $1s^2,2s^22p_x^22p_y^12p_z^0$ which is determined by

(1) Aufbau's principle (2) Pauli's exclusion principle

(3) Hund's rule (4) Uncertainty principle

26. For sodium atom the number of electrons with m = 0 will be :

(1) 2 (2) 7 (3) 9 (4) 8

Exercise-1

27. **Assertion :** Hydrogen has one electron in its orbit but it produces several spectral lines.
Reason : There are many excited energy levels available.
(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

28. **Assertion :** The energy of an electron is largely determined by its principal quantum number.
Reason : The principal quantum number (n) is a measure of the most probable distance of finding the electron around the nucleus.
(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

Exercise-3

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

OFFLINE JEE-MAIN

1. Which of the following ions has the maximum magnetic moment ? **[AIEEE 2002, 3/225]**
(1) Mn^{2+} (2) Fe^{2+} (3) Ti^{2+} (4) Cr^{2+}

2. Energy of H-atom in the ground state is –13.6 eV, hence energy in the second excited state is :
[AIEEE 2002, 3/225]
[AIEEE 2002, 3/225]
(1) – 6.8 eV (2) – 3.4 eV (3) – 1.51 eV (4) – 4.53 eV

3. Uncertainity in position of a particle of 25 g in space is 10^{-15} m. Hence, Uncertainity in velocity (m.sec^{-1}) is: (plank's constant, h = 6.6×10^{-34} Js) **[AIEEE 2002, 3/225]**
(1) 2.1×10^{-18} (2) 2.1×10^{-34} (3) 0.5×10^{-34} (4) 5.0×10^{-24}

4. The de-Broglie wavelength of a tennis ball of mass 60 g moving with a velocity of 10 m/s is approximately. (planck's constant, h = 6.63×10^{-34} J-s) **[AIEEE 2003, 3/225]**
(1) 10^{-33} m (2) 10^{-31} m (3) 10^{-16} m (4) 10^{-25} m

5. In Bohr series of lines of hydrogen spectrum, the third line from the red end corresponds to which one of the following inner-orbit jumps of the electron for Bohr orbits in an atom of hydrogen ?
[AIEEE 2003, 3/225]
(1) $3 \rightarrow 2$ (2) $5 \rightarrow 2$ (3) $4 \rightarrow 1$ (4) $2 \rightarrow 5$

6. The numbers of d-electrons retained in Fe^{2+} (atomic number Fe = 26) ion is **[AIEEE 2003, 3/225]**
(1) 3 (2) 4 (3) 5 (4) 6

Exercise-1

7. The orbital angular momentum for an electron revolving in an orbit is given by $\sqrt{\ell(\ell+1)}\,\frac{h}{2\pi}$. This momentum for an s-electron will be given by **[AIEEE 2003, 3/225]**

(1) $+\frac{1}{2}\cdot\frac{h}{2\pi}$ (2) Zero (3) $\frac{h}{2\pi}$ (4) $\sqrt{2}\cdot\frac{h}{2\pi}$

8. Which one of the following groupings represents a collection of isoelectronic species?
(At. nos. : Cs-55, Br-35) **[AIEEE 2003, 3/225]**

(1) Na^+, Ca^{2+}, Mg^{2+} (2) N^{3-}, F^-, Na^+ (3) Be, Al^{3+}, Cl^- (4) Ca^{2+} , Cs^+, Br.

9. The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be (Rydberg constant = 1.097×10^7 m^{-1}) **[AIEEE 2004, 3/225]**

(1) 91 nm (2) 192 nm (3) 406 (4) 9.1×10^{-6} nm

10. Which of the following set a of quantum numbers is correct for an electron in 4f orbital ? **[AIEEE 2004, 3/225]**

(1) n = 4, l = 3, m = +4, s = +1/2 (2) n = 4, l = 4, m = –4, s = –1/2

(3) n = 4, l = 3, m = +1, s = +1/2 (4) n = 3, l=2, m =–2, s = +1/2

11. Consider the ground state of Cr atom (Z = 24). The numbers of electrons with the azimuthal quantum numbers, ℓ = 1 and 2 are, respectively **[AIEEE 2004, 3/225]**

(1) 12 and 4 (2) 12 and 5 (3) 16 and 4 (4) 16 and 5

12. Which of the following statements in relation to the hydrogen atom is correct ? **[AIEEE 2005, 4½/225]**

(1) 3s, 3p and 3d orbitals all have the same energy
(2) 3s and 3p orbitals are of lower energy than 3d orbital
(3) 3p orbital is lower in energy than 3d orbital
(4) 3s orbital is lower in energy than 3p orbital

13. In a multi-electron atom, which of the following orbitals described by the three quantum numbers will have the same energy in the absence of magnetic and electric field ? **[AIEEE 2005, 3/225]**

(i) n = 1, l = 0, m = 0 (ii) n = 2, l = 0, m = 0 (iii) n = 2, l = 1, m = 1 (iv) n = 3, l = 2, m =1
(v) n = 3, l = 2, m = 0

(1) (iv) and (v) (2) (iii) and (iv) (3) (ii) and (iii) (4) (i) and (ii)

14. Uncertainity in the position of an electron (mass = 9.1×10^{-31} Kg) moving with a velocity 300 $m.sec^{-1}$, Accurate upto 0.001%, will be : (h = 6.63×10^{-34} J-s) **[AIEEE 2006, 3/165]**

(1) 19.2×10^{-2} m (2) 5.76×10^{-2} m (3) 1.92×10^{-2} m (4) 3.84×10^{-2} m

15. According to Bohr's theory, the angular momentum to an electron in 5th orbit is : **[AIEEE 2006, 3/165]**

(1) $25\,\frac{h}{\pi}$ (2) $1.0\,\frac{h}{\pi}$ (3) $10\,\frac{h}{\pi}$ (4) $2.5\,\frac{h}{\pi}$

Exercise-1

16. The 'spin-only' magnetic moment [in units of Bohr magneton (μ_β)] of Ni^{2+} in aqueous solution would be (Atomic number : Ni = 28) **[AIEEE 2006, 3/165]**

(1) 2.84 (2) 4.90 (3) 0 (4) 1.73

17. Which of the following nuclear reactions will generate an isotope ? **[AIEEE 2007, 3/120]**

(1) Neutron particle emission (2) Positron emission

(3) α-particle emission (4) β-particle emission

18. Which of the following set of quantum numbers represents the highest energy of an atom ? **[AIEEE 2007, 3/105]**

(1) n = 3, l = 0, m = 0, s = $+\frac{1}{2}$ (2) n = 3, l = 1, m =1, s = $+\frac{1}{2}$

(3) n = 3, l = 2, m = 1, s = $+\frac{1}{2}$ (4) n = 4, l = 0, m = 0, s = $+\frac{1}{2}$

19. The ionisation enthalpy of hydrogen atom is 1.312×10^6 J mol^{-1}. The energy required to excite the electron in the atom from $n_1 = 1$ to n = 2 is **[AIEEE 2008, 3/105]**

(1) 8.51×10^5 J mol^{-1} (2) 6.56×10^5 J mol^{-1} (3) 7.56×10^5 J mol^{-1} (4) 9.84×10^5 J mol^{-1}

20. Which one of the following constitutes a group of the isoelectronic species? **[AIEEE 2008, 3/105]**

(1) NO^+, C_2^{2-}, CN^-, N_2 (2) CN^-, N_2, O_2^{2-}, C_2^{2-} (3) N_2, O_2^-. NO^+, CO (4) C_2^{2-}, O_2^-, CO, NO

21. Calculate the wavelength (in nanometer) associated with a proton moving at 1.0×10^3 m s^{-1} (Mass of proton = 1.67×10^{-27} kg and h = 6.63×10^{-34} J-s) : **[AIEEE 2009, 4/144]**

(1) 0.40 nm (2) 2.5 nm (3) 14.0 nm (4) 0.032 nm

22. In an atom, an electron is moving with a speed of 600 m/s with an accuracy of 0.005%. Certainity with which the position of the electron can be located is (h = 6.6×10^{-34} kg m^2 s^{-1}, mass of electron, e_m = 9.1 × 10^{-31} kg): **[AIEEE 2009, 4/144]**

(1) 5.10×10^{-3} m (2) 1.92×10^{-3} m (3) 3.83×10^{-3} m (4) 1.52×10^{-4} m

23. The energy required to break one mole of Cl–Cl bonds in Cl_2 is 242 kJ mol^{-1}. The longest wavelength of light capable of breaking a single Cl–Cl bond is : (c = 3×10^8 m s^{-1} and $N_A = 6.02 \times 10^{23}$ mol^{-1}) **[AIEEE 2010, 8/144]**

(1) 594 nm (2) 640 nm (3) 700 nm (4) 494 nm

24. Ionisation energy of He^+ is 19.6×10^{-18} J $atom^{-1}$. The energy of the first stationary state (n = 1) of Li^{2+} is : **[AIEEE 2010, 8/144]**

(1) 4.41×10^{-16} J $atom^{-1}$ (2) -4.41×10^{-17} J $atom^{-1}$

(3) -2.2×10^{-15} J $atom^{-1}$ (4) 8.82×10^{-17} J $atom^{-1}$

25. A gas absorbs a photon of 355 nm and emits at two wavelengths. If one of the emission is at 680 nm, the other is at : **[AIEEE 2011, 4/120]**

(1) 1035 nm (2) 325 nm (3) 743 nm (4) 518 nm

26. The frequency of light emitted for the transition n = 4 to n = 2 of He^+ isequalto the transition in H atom corresponding to which of the following? **[AIEEE 2011, 4/120]**

(1) n = 2 to n = 1 (2) n = 3 to n = 2 (3) n = 4 to n = 3 (4) n = 3 to n = 1

27. The electrons identified by quantum numbers n and ℓ: **[AIEEE 2012, 4/120]**

Exercise-1

(a) n = 4, ℓ = 1 (b) n = 4, ℓ = 0 (c) n = 3, ℓ = 2 (d) n = 3, ℓ = 1

can be placed in order of increasing energy as :

(1) (c) < (d) < (b) < (a) (2) (d) < (b) < (c) < (a) (3) (b) < (d) < (a) < (c) (4) (a) < (c) < (b) < (d)

28. Energy of an electron is given by $E = -2.178 \times 10^{-18} J \left(\frac{Z^2}{n^2}\right)$. Wavelength of light required to excite an electron in an hydrogen atom from level n = 1 to n = 2 will be : **[JEE(Main)2013, 4/120]**

($h = 6.62 \times 10^{-34}$ Js and $c = 3.0 \times 10^8$ ms^{-1})

(1) 1.214×10^{-7} m (2) 2.816×10^{-7} m (3) 6.500×10^{-7} m (4) 8.500×10^{-7} m

29. The correct set of four quantum numbers for the valence electrons of rubidium atom (Z = 37) is : **[JEE(Main)2014, 4/120]**

(1) 5, 0, 0, $+\frac{1}{2}$ (2) 5, 1, 0, $+\frac{1}{2}$ (3) 5,1, 1, $+\frac{1}{2}$ (4) 5, 0, 1, $+\frac{1}{2}$

30. Which of the following is the energy of a possible excited state of hydrogen ? **[JEE(Main) 2015, 4/120]**

(1) +13.6 eV (2) –6.8 eV (3) –3.4 eV (4) +6.8 eV

31. A stream of electrons from a heated filament was passed between two charged plates kept at a potential difference V esu. If e and m are charge and mass of an electron, respectively, then the value of h/λ (where λ is wavelength associated with electron wave) is given by : **[JEE(Main) 2016, 4/120]**

(1) 2meV (2) $\sqrt{meV}$ (3) $\sqrt{2meV}$ (4) meV

32. The radius of the second Bohr orbit for hydrogen atom is :

(Planck's Const. $h = 6.6262 \times 10^{-34}$ Js; mass of electron = 9.1091×10^{-31} kg; charge of electron $e = 1.60210 \times 10^{-19}$ C; permittivity of vacuum $\epsilon_0 = 8.854185 \times 10^{-12}$ $kg^{-1}m^{-3}A^2$)

[JEE(Main) 2017, 4/120]

(1) 4.76 Å (2) 0.529 Å (3) 2.12 Å (4) 1.65 Å

ONLINE JEE-MAIN

1. The energy of an electron in first Bohr orbit of H-atom is –13.6 eV. The energy value of electron in the excited state of Li^{2+} is : **[JEE(Main) 2014 Online (09-04-14), 4/120]**

(1) – 27.2 eV (2) 30.6 eV (3) – 30.6 eV (4) 27.2 eV

2. If λ_0 and λ be the threshold wavelength and wavelength of incident light, the velocity of photoelectron ejected from the metal surface is : **[JEE(Main) 2014 Online (11-04-14), 4/120]**

(1) $\sqrt{\frac{2h}{m}(\lambda_0 - \lambda)}$ (2) $\sqrt{\frac{2hc}{m}(\lambda_0 - \lambda)}$ (3) $\sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$ (4) $\sqrt{\frac{2h}{m}\left(\frac{1}{\lambda_0} - \frac{1}{\lambda}\right)}$

3. Based on the equation : $\Delta E = 2.0 \times 10^{-18} J \left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$

Exercise-1

the wavelength of the light that must be absorbed to excite hydrogen electron from level n = 1 to level n = 2 will be : (h = 6.625 × 10^{-34} Js, C = 3 × 10^{8} ms^{-1}) **[JEE(Main) 2014 Online (09-04-14), 4/120]**

(1) 1.325 × 10^{-7} m (2) 1.325 × 10^{-10} m (3) 2.650 × 10^{-7} m (4) 5.300 × 10^{-10} m

4. If m and e are the mass and charge of the revolving electron in the orbit of radius r for hydrogen atom, the total energy of the revolving electron will be : **[JEE(Main) 2014 Online (12-04-14), 4/120]**

(1) $\frac{1}{2}\frac{e^2}{r}$ (2) $-\frac{e^2}{r}$ (3) $\frac{me^2}{r}$ (4) $-\frac{1}{2}\frac{e^2}{r}$

5. The de-Broglie wavelength of a particle of mass 6.63 g moving with a velocity of 100 ms^{-1} is : **[JEE(Main) 2014 Online (12-04-14), 4/120]**

(1) 10^{-33} m (2) 10^{-35} m (3) 10^{-31} m (4) 10^{-25} m

6. Excited hydrogen atom emits light in the ultraviolet region at 2.47 × 10^{15} Hz With thi frequency, the energy of a single photon is : (h = 6.63 × 10^{-34} Js) **[JEE(Main) 2014 Online (12-04-14), 4/120]**

(1) 8.041 × 10^{-40} J (2) 8.041 × 10^{-19} J (3) 1.640 × 10^{-18} J (4) 6.111 × 10^{-17} J

7. Ionization energy of gaseous Na atom is 495.5 kJ mol^{-1}. The lowest possible frequency of light that ionizes a sodium atom is (h = 6.626 × 10^{-34} Js, N_A = 6.022 × 10^{23} mol^{-1}) **[JEE(Main) 2014 Online (19-04-14), 4/120]**

(1) 7.50 × 10^{4} s^{-1} (2) 4.76 × 10^{14} s^{-1} (3) 3.15 × 10^{15} s^{-1} (4) 1.24 × 10^{15} s^{-1}

8. If the principal quantum number n = 6, the correct sequence of filling of electrons will be : **[JEE(Main) 2015 Online (10-04-15), 4/120]**

(1) ns → np → (n – 1)d → (n – 2)f (2) ns → (n – 1)d → (n – 2)f → np

(3) ns → (n – 2)f → np → (n – 1)d (4) ns → (n – 2)f → (n – 1)d → np

9. At temperatuere T, the average kinetic energy of any particle is $\frac{3}{2}$ KT. The de Broglie wavelength follows the order : **[JEE(Main) 2015 Online (11-04-15), 4/120]**

(1) Visible photon > Thermal neutron > Thermal electron

(2) Thermal proton > Thermal electon > Visible photon

(3) Thermal proton > Visible photon > Thermal electron

(4) Visible photon > Thermal electron > Thermal neutron

10. The total number of orbitals associated with the principal quantum number 5 is: **[JEE(Main) 2016 Online (09-04-16), 4/120]**

(1) 5 (2) 20 (3) 25 (4) 10

11. Aqueous solution of which salt will not contain ions with the electronic configuration $1s^22s^22p^63s^23p^6$? **[JEE(Main) 2016 Online (10-04-16), 4/120]**

(1) NaCl (2) CaI_2 (3) NaF (4) KBr

12. If the shortest wavelength in Lyman series of hydrogen atom is A, then the longest wavelength in Paschen series of He^+ is : **[JEE(Main) 2017 Online (08-04-17), 4/120]**

(1) $\frac{36A}{5}$ (2) $\frac{9A}{5}$ (3) $\frac{5A}{9}$ (4) $\frac{36A}{7}$

13. The electron in the hydrogen atom undergoes transition from higher orbitals to orbitals of radius 211.6 pm. This transition is associated with : **[JEE(Main) 2017 Online (09-04-17), 4/120]**

(1) Paschen series (2) Brackett series (3) Lyman series (4) Balmer series

PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

1. Rutherford's experiment, which established the nuclear model of the atom, used a beam of : **[JEE 2002(S), 3/90]**

(A) β-particles, which impinged on a metal foil & got absorbed.

(B) γ-rays, which impinged on a metal foil & ejected electrons.

(C) helium atoms, which impinged on a metal foil & got scattered.

(D) helium nuclei, which impinged on a metal foil & got scattered.

2. If nitrogen atom had electronic configuration $1s^7$, it would have energy lower than that of the normal ground state configuration $1s^2\ 2s^2\ 2p^3$, because the electrons would be close to nucleus, yet $1s^7$ is not observed because it violates : **[JEE 2002(S), 3/90]**

(A) Heisenberg uncertainty principle (B) Hund's rule

(C) Pauli's exclusion principle (D) Bohr's postulate of stationary orbits.

3. The orbit having Bohr radius equal to 1st Bohr orbit of H–atom is **[JEE 2004(S), 3/84]**

(A) n = 2 of He^{+} (B) n = 2 of B^{+4} (C) n = 3 of Li^{+2} (D) n = 2 of Be^{+3}

4. Number of radial nodes in 3s and 2p orbitals (respectively) are : **[JEE 2004(S), 3/84]**

(A) 2, 0 (B) 2, 1 (C) 3, 2 (D) 2, 2

Paragraph for Question Nos. 5 to 7

The hydrogen-like species Li^{2+} is in a spherically symmetric state S_1 with one radial node. Upon absorbing light the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the hydrogen atom.

5. The state S_1 is : **[JEE 2010, 3/163]**

(A) 1s (B) 2s (C) 2p (D) 3s

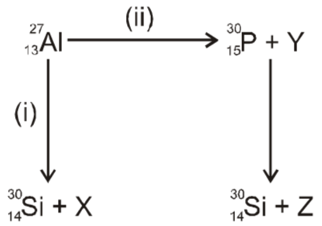
6. Energy of the state S_1 in units of the hydrogen atom ground state energy is : **[JEE 2010, 3/163]**

(A) 0.75 (B) 1.50 (C) 2.25 (D) 4.50

7. The orbital angular momentum quantum number of the state S_2 is : **[JEE 2010, 3/163]**

(A) 0 (B) 1 (C) 2 (D) 3

8. Bombardment of aluminum by α-particle leads to its artificial disintegration in two ways, (I) and (ii) as shown. Products **X**, **Y** and **Z** respectively are, **[JEE 2011, 3/180]**

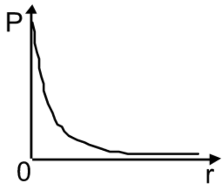


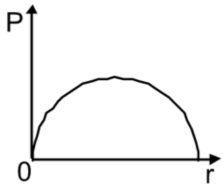
(A) proton, neutron, positron
(B) neutron, positron, proton
(C) proton, positron, neutron
(D) positron, proton, neutron

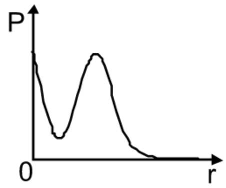
9. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [a_0 is Bohr radius] : **[JEE 2012, 3/136]**

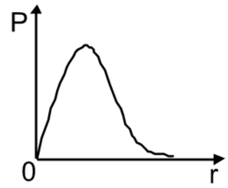
(A) $\frac{h^2}{4\pi^2 m a_0^2}$
(B) $\frac{h^2}{16\pi^2 m a_0^2}$
(C) $\frac{h^2}{32\pi^2 m a_0^2}$
(D) $\frac{h^2}{64\pi^2 m a_0^2}$

10. P is the probability of finding the 1s electron of hydrogen atom in a spherical shell of infinitesimal thickness, dr, at a distance r from the nucleus. The volume of this shell is $4\pi r^2 dr$. The qualitative sketch of the dependence of P on r is **[JEE(Advanced) 2016, 3/124]**

(A) 

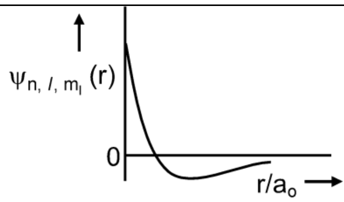
(B) 

(C) 

(D) 

Answer Q.11, Q.12 and Q.13 by appropriately matching the information given in the three columns of the following table.

The wave function, ψ_{n,l,m_l} is a mathematical function whose value depends upon spherical polar coordinates (r, θ, φ) of the electron and characterized by the quantum numbers *n*, *l* and m_l. Here r is distance from nucleus, θ is colatitude and φ is azimuth. In the mathematical functions given in the Table, Z is atomic number and a_o is Bohr radius.

Column 1	**Column 2**	**Column 3**
(I) 1s orbital	(i) $\psi_{n,l,m_l} \propto \left(\frac{Z}{a_o}\right)^{\frac{3}{2}} e^{-\left(\frac{Zr}{a_o}\right)}$	(P) 
(II) 2s orbital	(ii) One radial node	(Q) Probability density at nucleus $\propto \frac{1}{a_o^3}$
(III) $2p_z$ orbital	(iii) $\psi_{n,l,m_l} \propto \left(\frac{Z}{a_o}\right)^{\frac{5}{2}} r e^{-\left(\frac{Zr}{2a_o}\right)} \cos\theta$	(R) Probability density is maximum at nucleus

Exercise-1

(IV) $3d_{z^2}$ orbital	(iv) xy-plane is a nodal plane	(S) Energy needed to excite electron from n = 2 state to n = 4 state is $\frac{27}{32}$ times the energy needed to excite electron from n = 2 state to n = 6 state

11. For He^+ ion, the only **INCORRECT** combination is **[JEE(Advanced) 2017, 3/122]**

(A) (I) (i) (S) (B) (II) (ii) (Q) (C) (I) (iii) (R) (D) (I) (i) (R)

12. For the given orbital in Column 1, the only **CORRECT** combination for any hydrogen-like species is **[JEE(Advanced) 2017, 3/122]**

(A) (II) (ii) (P) (B) (I) (ii) (S) (C) (IV) (iv) (R) (D) (III) (iii) (P)

13. For hydrogen atom, the only **CORRECT** combination is **[JEE(Advanced) 2017, 3/122]**

(A) (I) (i) (P) (B) (I) (iv) (R) (C) (II) (i) (Q) (D) (I) (i) (S)

Exercise-1

Answers

EXERCISE - 1

A-1.	(2)	**A-2.**	(4)	**A-3.**	(2)	**A-4.**	(1)	**A-5.**	(2)
A-6.	(3)	**A-7.**	(2)	**A-8.**	(4)	**A-9.**	(2)	**A-10.**	(4)
A-11.	(4)	**A-12.**	(2)	**A-13.**	(4)	**A-14.**	(3)	**A-15.**	(3)
A-16.	(4)	**A-17.**	(3)	**A-18.**	(4)	**B-1.**	(1)	**B-2.**	(2)
B-3.	(1)	**B-4.**	(3)	**B-5.**	(2)	**B-6.**	(4)	**B-7.**	(1)
B-8.	(1)	**B-9.**	(1)	**B-10.**	(1)	**B-11.**	(1)	**B-12.**	(3)
C-1.	(2)	**C-2.**	(3)	**C-3.**	(2)	**C-4.**	(3)	**C-5.**	(2)
C-6.	(1)	**C-7.**	(3)	**C-8.**	(3)	**C-9.**	(2)	**C-10.**	(3)
C-11.	(2)	**C-12.**	(3)	**C-13.**	(4)	**D-1.**	(3)	**D-2.**	(4)
D-3.	(1)	**D-4.**	(1)	**D-5.**	(2)	**D-6.**	(3)	**D-7.**	(4)
D-8.	(2)	**D-9.**	(4)	**D-10.**	(3)	**D-11.**	(1)	**D-12.**	(1)
D-13.	(2)	**D-14.**	(4)	**D-15.**	(1)	**D-16.**	(1)	**D-17.**	(1)
D-18.	(3)	**E-1.**	(4)	**E-2.**	(2)	**E-3.**	(3)	**E-4.**	(1)
E-5.	(3)	**E-6.**	(3)	**E-7.**	(3)	**E-8.**	(4)	**E-9.**	(1)
E-10.	(2)	**E-11.**	(1)	**E-12.**	(1)	**E-13.**	(1)	**E-14.**	(4)
E-15.	(3)	**F-1.**	(2)	**F-2.**	(1)	**F-3.**	(1)	**F-4.**	(3)
F-5.	(3)	**F-6.**	(4)	**F-7.**	(4)	**F-8.**	(4)	**F-9.**	(2)
F-10.	(4)	**F-11.**	(1)	**F-12.**	(3)	**F-13.**	(3)	**F-14.**	(1)
F-15.	(1)	**F-16.**	(4)	**F-17.**	(3)	**F-18.**	(3)	**F-19.**	(2)

EXERCISE - 2

PART - I

1.	(4)	**2.**	(3)	**3.**	(2)	**4.**	(3)	**5.**	(1)
6.	(3)	**7.**	(3)	**8.**	(2)	**9.**	(4)	**10.**	(3)
11.	(3)	**12.**	(2)	**13.**	(4)	**14.**	(4)	**15.**	(2)
16.	(2)	**17.**	(2)	**18.**	(3)	**19.**	(1)	**20.**	(4)
21.	(1)	**22.**	(1)	**23.**	(3)	**24.**	(2)	**25.**	(3)
26.	(2)	**27.**	(1)	**28.**	(1)				

EXERCISE - 3

PART - I

OFFLINE JEE-MAIN

1.	(1)	**2.**	(3)	**3.**	(1)	**4.**	(1)	**5.**	(2)
6.	(4)	**7.**	(2)	**8.**	(2)	**9.**	(1)	**10.**	(3)
11.	(2)	**12.**	(1)	**13.**	(1)	**14.**	(3)	**15.**	(4)
16.	(1)	**17.**	(1)	**18.**	(3)	**19.**	(4)	**20.**	(1)
21.	(1)	**22.**	(2)	**23.**	(4)	**24.**	(2)	**25.**	(3)
26.	(1)	**27.**	(2)	**28.**	(1)	**29.**	(1)	**30.**	(3)
31.	(3)	**32.**	(3)						

ONLINE JEE-MAIN

1.	(3)	**2.**	(3)	**3.**	(1)	**4.**	(4)	**5.**	(1)
6.	(3)	**7.**	(4)	**8.**	(4)	**9.**	(4)	**10.**	(3)
11.	(3)	**12.**	(4)	**13.**	(4)				

PART - II

1.	(D)	**2.**	(C)	**3.**	(D)	**4.**	(A)	**5.**	(B)
6.	(C)	**7.**	(B)	**8.**	(A)	**9.**	(C)	**10.**	(D)
11.	(C)	**12.**	(A)	**13.**	(D)				